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SOUTHEASTERN FOREST
EXPERIMENT STATION
Asheville, North Carolina
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INTRODUCTION

The national obligation for defense and foreign aid brings a pinch on normal services of the federal government, including forest research. Inflation not compensated by appropriations has meant a steady decline for several years in the Station's research efforts. While appropriations have remained about the same, the value of the research dollar has shrunk greatly. This has been offset only in part by an increase in cooperative research funds.

Pressing from the other direction is an increasing need for more research to guide the rapid expansion of the South's tremendous forest enterprise. More accurate information on the location and extent of timber supplies is in great demand. The increase in intensive forest management practices in the Southeast is crowding the rate at which such practices can be assisted by research. Information is needed now on forest genetics, on forest regeneration of dry sandy areas, on reclamation and management of poorly drained areas, and on utilization of less valuable and little-used species--problems that have been largely passed over in earlier research because of lack of "consumer" interest. There is no lack of such interest now.

The shrinkage of the research dollar in the face of increasing needs for information demands a solution. It lies in the joint effort of all forestry groups in the region working together to meet the research needs. Research by States, industries, and forestry schools got a late start in the Southeast, but is coming along rapidly. It is now a major part of the whole research pattern.

In view of these trends the Station has increased its efforts to coordinate its program with that of other groups. It has enlisted the help of others where such help is available, as attested by this report. It has initiated grants-in-aid to others in the research field who are better equipped to solve particular problems. It has made increasing use of local advisory committees to assure that its studies are best geared to the needs of the local people and to the programs of cooperating agencies.

The Station will continue to foster this cooperative approach toward common problems. It will continue to concentrate on certain long-range, fundamental, or regional jobs which are by nature a federal responsibility. It will also work side by side with all those in the Southeast who can help in developing the "know-how" to best promote the future progress of the forest economy of this region.

FOREST MANAGEMENT

Forest management research in the Southeast is confronted with many challenging problems in the growth and harvesting of timber crops. Increasing population pressure and maintenance of a multi-billion dollar forest industry require that idle lands be reforested, partially stocked woodlands raised to full productivity, and well stocked stands perpetuated. These problems are being attacked by the Station in cooperation with the states, with industry, and others, at several Research Centers located in each of the major forest areas of the Southeast. The needed information is obtained in intensive project studies, through trials of different management systems on 30- to 100-acre compartments on experimental forests, and by pilot-plant operations on a larger scale.

REGENERATION

Starting a new forest crop is probably the most important forest management activity. Failure to promptly secure a well stocked, evenly distributed stand of the best species for a particular site penalizes the landowner throughout the next rotation by loss of potential volume growth. Furthermore, any subsequent effort he makes to bring the stand up to full productivity requires an additional outlay of labor and money. Consequently, the Station has devoted as much attention to solution of the regeneration problem as to any phase of forest management. Some of these experiments have begun to pay handsome dividends.

Loblolly Pine

Considerable information was obtained prior to 1952 about seed production, seed dispersal, seedbed requirements, and hardwood control problems involved in the regeneration of loblolly pine. For example, good seed crops occur at irregular intervals of from 1 to 5 years. The expected size of the next seed crop can be predicted a year in advance of seedfall by determining the ratio between immature conelets and mature cones of the last crop. Second-growth loblolly pines in pulpwood-age stands, usually too immature to be considered for seed production, can be stimulated to produce large seed crops by completely releasing each chosen seed tree from competition by its neighbors. This should be done 3 years in advance of the final harvest date. In mature stands, the possibilities for abundant seedfall in the first season following harvest can be increased by careful selection of the trees to be left. Trees 12 inches in diameter or larger with a large number of old cones in sight have been found to be most prolific. During poor seed years the possibility of obtaining an adequate stand of reproduction can be greatly enhanced by a type of seedbed preparation that will expose mineral soil. Both prescribed burning and mechanical scarification with disks or bulldozers are satisfactory. These treatments also reduce hardwood competition, a major problem in itself on moist, fertile sites. Much of the research in hardwood control has been with chemical silvicides, the most promising being 2,4-D, ammonium sulfamate ("Ammate"), and 2,4,5-T. The extent of public

interest in silvicides is indicated by requests for more than 7,000 copies of Station Paper No. 10, "The Use of Chemicals to Control Inferior Trees in the Management of Loblolly Pine," issued in September 1951.

During 1952 much additional knowledge has been obtained from current studies; some of the more important findings are listed here.

Intensive tests of seed-tree stimulation by application of commercial fertilizer to the soil around each tree revealed a significant increase in cone production of 25-year-old trees. However, 40-year-old trees failed to respond satisfactorily, perhaps because of insufficient treatment or prior release. Although fertilizer treatments are too expensive for use in seed-tree cuttings, they could be a profitable aid in seed orchard culture.

In southeastern Virginia, results of earlier research in loblolly pine seed and seedbed requirements received practical application on private land some distance from the Bigwoods Experimental Forest. The pulpwood-size timber on this tract was removed in a partial cut, the intent being to remove the larger trees later if sufficient reproduction was obtained. Most of the ground not scarified during log skidding was disked so that 64 percent of the seedbed was disturbed soil, 16 percent was covered with slash concentrations, and 20 percent remained untouched. Seed production by the residual stand was measured with seed traps scattered about the tract. The statistics on seedbed condition and seed supply were then converted to the expected number of seedlings and percent stocking by use of information in Station Paper No. 8, "Seed and Seedbed Requirements to Regenerate Loblolly Pine." The final stand of seedlings was well within the predicted range. Thus forest industry is armed with one more tool for intensive management.

Seed crop forecasting also received commercial application in the Coastal Plain of Virginia and North Carolina. A bumper crop is forecast for 1953, although indications are that it will be larger near the coast than inland.

Because of the build-up of hardwood competition after seed-tree or strip clear cutting in loblolly pine, prompt establishment of reproduction has been recognized as an obvious requirement for success. Now it has been found that in addition to hardwood encroachment, delayed seeding of pines may also be responsible for stocking failures. An analysis of thirteen 40-acre managed compartments, cut during the years 1946 through 1950, disclosed that favorable seedbed conditions for loblolly pine disappear within 3 years after logging. Therefore a planned regeneration schedule should be a part of any harvest cutting program. Partial cuts should be scheduled for the years when seed crops are poor and cutting for regeneration concentrated in good seed years.

Sometimes, wet weather in late summer and early fall delays prescribed burning for seedbed preparation and hardwood control. However, winter fires in loblolly pine stands consume most of the seed that may be on the ground. Furthermore, few seeds are disseminated after February 1

from cones still on the trees, so restocking of winter burns probably will be delayed an additional year.

How and when to remove seed trees so as to minimize damage to reproduction received attention in eastern North Carolina. The tract contained an average of six good-sized seed trees per acre which were removed in the fall after their seeds had been disseminated. By locating landings in advance, encouraging cutters to fell trees directly toward or away from these spots, and skidding in tree lengths, damage to reproduction was confined to 16 percent of the area, of which only one-half was damaged severely. New seedlings from the last seed crop may later germinate in the skid roads, but planting is needed on loading areas where damage was complete.

As seedling behavior partially determines the adaptability of a species to a site, information has been secured about the growth of 1-year-old sweetgum and loblolly pine seedlings in soils of three different textures and under three levels of moisture supply. Although the sweetgum seedlings produced more dry matter and developed larger root systems, the growth in length of leaders and branches was less than that of the pines under all conditions of the experiment. However, field results might differ somewhat from those obtained in this greenhouse test.

Re-establishment of Loblolly and Slash Pine

The common practice of clear cutting frequently results in obtaining scrub hardwoods instead of a new crop of pines. Understory hardwoods, ever present in the merchantable stands of the Georgia Piedmont, soon close the canopy and preclude the successful establishment of pines. Fifteen percent of the pine uplands of this region, estimated to aggregate two million acres in area, already have reverted to brush and low value hardwoods. Planting will have to be resorted to if we want to grow another crop of pine on these acres. Even so, establishment of planted pines in recently cut-over woods, in competition with understory hardwoods, will never be as successful as old field planting. Some form of pretreating the planting site may be necessary. Such a test has been made near Athens, Georgia, in cooperation with the School of Forestry, University of Georgia.

Loblolly and slash pines were planted immediately after logging on plots that received various treatments for hardwoods control. Mere cutting of understory hardwoods was of no benefit. Cutting all hardwoods over 2 inches in diameter and broadcast burning, or grubbing out the hardwood root stocks, provided 25 to 30 percent more free-growing seedlings than no treatment. For all treatments, loblolly pine displayed considerably better survival, greater height growth, and more free-growing seedlings than slash pine. The recommended commercial practice on similar sites would be chopping the brush with a tractor-drawn Marden brush cutter or broadcast burning. Hardwoods above 4 inches in diameter could be poisoned with Ammate or 2,4,5-T.

Reforestation of South Florida Slash Pine Sites

South Florida slash pine (Pinus elliottii, var. densa), a distinct botanical variety of native American slash pine, occurs on an area of approximately 1,750,000 acres in the southernmost portion of Florida. About one million acres of the type is denuded and cannot be reforested naturally for lack of an adequate seed source. Another half million acres is understocked.

This problem is the subject of cooperative research by the Collier Company, Atlantic Land and Improvement Company, Florida Forest Service, Hendry County, and the Southeastern Station. The project is still too new to permit any recommendations for reforestation, but it is known that planted seedlings succumb readily to extreme variations of flood and drought, while cotton rats have consumed much of the seed sown in direct-seeding trials.

Sand Pine Regeneration

Sustained yield management of a 210,000-acre stand of sand pine on the Ocala National Forest, having a potential annual harvest of 35,000 cords, hinges upon discovery of some harvest-cutting technique or treatment that will result in regeneration of the stand. In nature, the persistent cones on living trees open when wildfires of killing intensity sweep through the forest. If temperature and moisture conditions are favorable, a new generation is born. But foresters have not yet developed an artificial means of obtaining the same result. So far, seedbed preparation with a Marden brush cutter or heavy duty disk, in conjunction with lopping and scattering, results in the most seedlings if treatment is applied in late summer or fall about 4 to 6 weeks after harvest cutting. Seeds released at other seasons either are consumed by ants, rodents and birds, or germinate and fail to survive the hot summer months.

THINNING

More Man-hours Required to Harvest Small Trees

Silvicultural treatments sometimes need to be modified to meet economic requirements. For example, thinnings should provide an economically operable cut. A better understanding of cost factors in harvesting pulpwood from thinnings has been obtained on the Hitchiti Experimental Forest in a study of the relationship between tree size and production rate on a chain-saw operation. Cutting a cord of wood from 5-inch trees takes twice as long as from 9-inch trees. The actual man-hours per cord required to fell, limb, and buck average trees of varying diameter are shown in table 1.

These figures represent 60 percent of the total time involved. The remaining 40 percent was constant regardless of tree size and was subdivided as follows: 20 percent for walking between trees and occasional swamping, 17 percent for on-the-job equipment delays, and 3 percent for hang-ups.

Table 1.--Man-hours per cord to fell, limb, and buck pine pulpwood

D.b.h. (Inches)	Felling	Limbing and bucking	Total
	Man-hours	Man-hours	Man-hours
5	0.65	0.93	1.58
6	.44	.78	1.22
7	.33	.67	1.00
8	.28	.57	.85
9	.24	.52	.76
10	.22	.47	.69
11	.20	.44	.64
12	.19	.41	.60

Early Competition in Slash Pine Plantations

A study of slash pine seedlings planted on 6 x 6-foot and 12 x 12-foot spacings revealed significant difference in diameter growth due to competition but no marked difference in height growth. Competition in the 6 x 6-foot planting began as early as the third year after planting. At the end of 7 years slash pines in the 12 x 12-foot plantation averaged about 1 inch larger in diameter than those more closely spaced. The 6 x 6-foot spacing produced a greater total basal area, and also resulted in better natural pruning. Spacings as wide as 12 x 12 feet are not recommended generally. Nevertheless, plantation managers should be aware that competition can occur at a rather early age in close spacings of slash pine and that the maximum diameter growth of potential crop trees is not realized at these close spacings. Also, consideration must be given to costs of harvesting close-spaced trees unless provision is made for roads.

STAND IMPROVEMENT

In bygone days lumber prices were so low and utilization practices so primitive that markets could be found for only the best quality yellow-poplar, pine, and white oak. As prices rose and utilization improved, successive waves of loggers returned to high grade the forests. But always poorly formed or defective trees and those of inferior species were left behind. Thus by default millions of acres of once-productive forest land have been surrendered to inferior hardwoods.

Returning these lands to productivity is one of the major objectives of forest managers in the South today. The job is not as difficult as it seems. It can be accomplished by better utilization of inferior species, protecting valuable species as a source of seed, and eliminating hardwood competition by prescribed fire or the use of mechanical, chemical, or manual

methods. Such techniques have been the subject of numerous experiments in the loblolly pine type of the Coastal Plain.

GROWTH AND MORTALITY

Effect of Cutting Methods on Hardwood Growth

Regardless of how they are harvested, most Southern Appalachian forests come back in new growth that in time becomes merchantable. This is largely owing to a wealth of species and to favorable soil and climatic conditions for growth. But indiscriminate cutting needlessly lowers forest values and makes it harder to sustain future values. These conclusions arise from a study begun in 1930 on the Bent Creek Experimental Forest near Asheville, N. C., of a typical run-down mountain hardwood stand.

Three cutting treatments have been applied: (1) clear, (2) a flexible 14-inch diameter limit, and (3) selection for quality growth. Each method had certain advantages and disadvantages. Analysis of results 20 years later disclosed that no single treatment was best in all respects, although selection for quality gave the best all-around results. This method provided the greatest value increment, and only slightly less volume growth than the flexible diameter limit cutting. Clear cutting resulted in the greatest average annual growth of solid wood, mostly cordwood. It was too early for sawlogs--only 80 board feet per acre were produced in the 20-year study period.

Accretion in value of all wood products, expressed as an annual compound interest rate, was 0.5 percent for the uncut check, 5.0 percent for diameter limit, and 5.6 percent for selection, without taking into account the rise in timber values during the 20-year period. These results indicate that improvement cuttings, varied to fit the needs and objectives of individual landowners, can effect a tenfold increase in the annual earning power of the largest and most important forest type in the Southern Appalachians.

Response of Residual Saplings to Complete Release

Observations of clear-cut tracts on the Hitchiti Experiment Forest in central Georgia reveal that 31 percent of the residual saplings of long-suppressed shortleaf and loblolly pines died within 3 years after logging. The suppressed trees that survived showed a distinct increase in growth. A good correlation existed between diameter growth and initial crown ratio, while diameter increment was also associated with gain in crown ratio.

Effect of Winter Burning on Slash Pine Growth

In the flatwoods portion of southeast Georgia and northeast Florida, prescribed burning has become a recognized and necessary method of reducing fire hazard. This treatment enables land managers to remove the accumu-

lated growth of palmetto, gallberry, wire-grass, and leaf litter at a season when fires can be easily controlled. However, the method of burning may have a marked effect on the survival and subsequent growth of overstory trees.

Burning studies begun at the Lake City Research Center in 1944 reveal that winter headfires caused a marked reduction in subsequent height and diameter growth of slash pine, but backfires have little or no effect, providing the trees are more than 12 feet high. The tallest tree killed on plots burned by backfire was in the 8-foot height class, while headfires killed one tree 36 feet tall.

Effect of Fusiform Cankers

Six years' observation of loblolly pine trees with a diameter range of 11 to 17 inches at breast height indicates that fusiform cankers rarely weaken trees in the Santee River area enough to succumb to wind-breakage. But location of a canker within the first or second log of a tree has an important bearing on grade or yield.

FINANCIAL ASPECTS

Rules-of-thumb for Volume and Value in Pulpwood Trees

Questions about the volume and stumpage value of individual trees invariably arise during woodland operations. Usually it is inconvenient or impossible to consult a volume table for this information. The Station has developed convenient rules-of-thumb for determination of pulpwood volume and value of second-growth shortleaf and loblolly pines 8 to 13 inches in diameter. Where D is the tree diameter at breast height:

$$\text{Solid volume of rough wood in cu. ft.} = 4(D-6)$$

$$\text{Stacked volume of rough wood in cords} = \frac{4(D-6)}{100}$$

$$\text{Pulpwood stumpage value per tree} = \frac{4(D-6)}{100} \times \text{current pulpwood price per cord}$$

Comparative Stumpage Prices

Owners of second growth pine in the Southern Piedmont ought to know whether it is more valuable for pulpwood or for saw timber since integrated sales are uncommon in that region and lively competition exists between small sawmill operators and pulpwood contractors. With the aid of Station Paper No. 16, "Comparative Stumpage Prices for Small Pine Saw Timber and Pulpwood," timber owners can determine whether prevailing market conditions make it more profitable to sell stumpage as saw timber or as pulpwood. For example, if a seller is offered $5 a cord for 8-inch trees, figure 1 indicates that he cannot afford to sell them as saw timber unless he gets $20 a thousand or more (International 1/4-inch scale). Conversely,

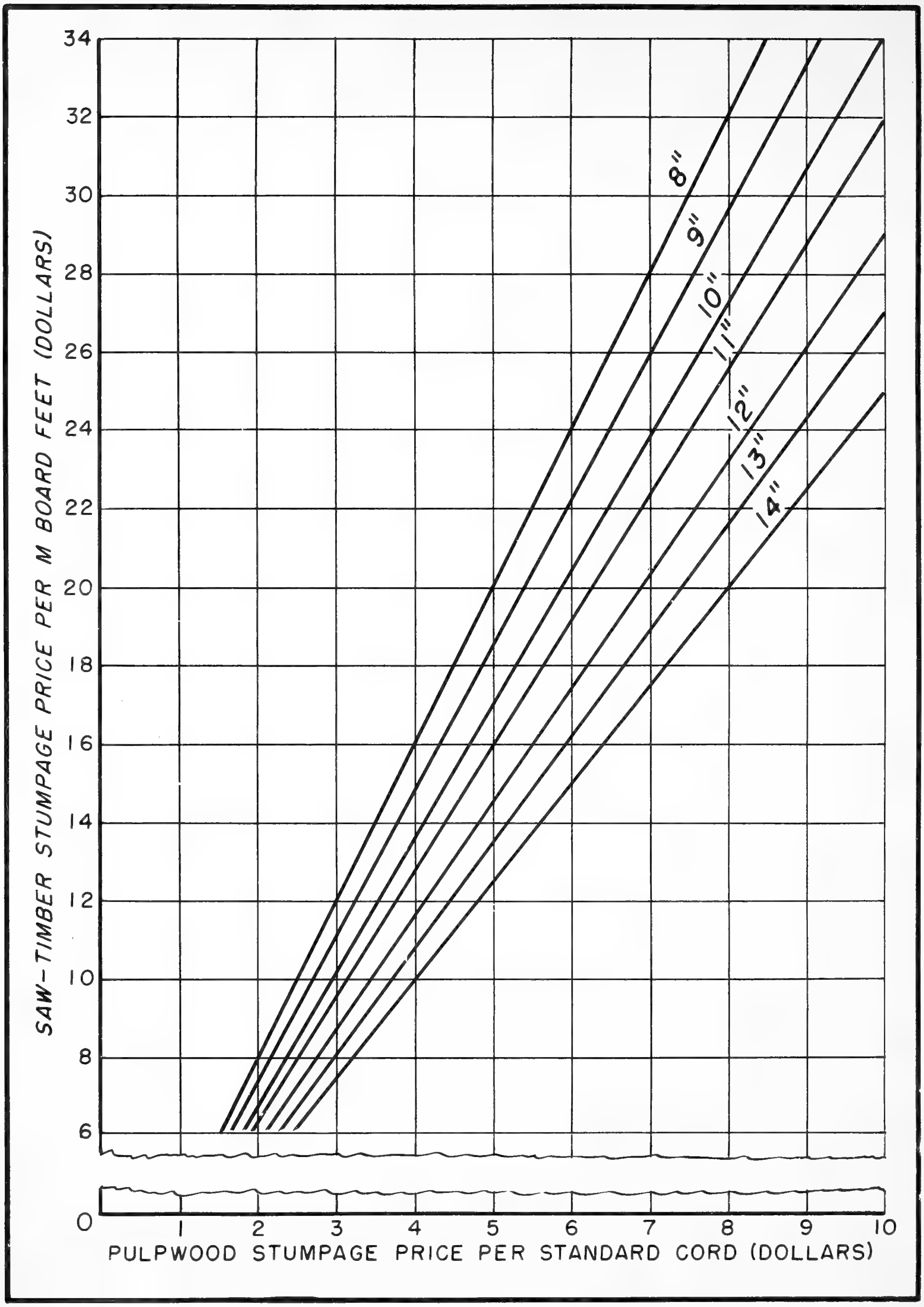

Figure 1.--Comparative stumpage prices for loblolly and shortleaf pine pulpwood and saw timber, International 1/4-inch scale, on the Hitchiti Experimental Forest. This scale most closely approximates a mill tally scale.

if he is offered $20 a thousand as saw timber for 8-inch trees, and $6 a cord as pulpwood, it will profit him most to sell as pulpwood. The figure is based on comparisons of the volume of cordwood (to a cordwood top limit) and saw timber (to a saw-timber limit) in trees of different sizes, as explained in Station Paper 16.

Timber Cutting and Skidding Costs in Southern Appalachians

Most timber operators have a fair idea of their total logging costs, but have not taken time to examine separate cost components. Consequently, they do not know where to start reducing costs when the profit margin shrinks below an acceptable limit.

The effect of tree size, species of timber, and type of equipment was studied on several typical operations within a 75-mile radius of Asheville, N. C. Felling and bucking time per M board feet was directly and closely related to tree size (fig. 2). Crew size with power equipment showed little difference in efficiency between two-, three-, or four-man crews, but delay time was much more costly with power equipment than with hand tools for the same size trees. Skidding time per thousand board feet was determined chiefly by distance traveled, while load size and slope were secondary factors, especially with power equipment. Capacity loads should always be carried regardless of motive power, a recommendation that is often made but seldom followed.

Managing Farm Woodlands

Small woodland owners control the greatest acreage of forest land in the Southeast, but practice the poorest forest management. To serve the needs of these owners, representative small woodland tracts have been set aside by the Station at each of seven experimental forests. They are used to test and demonstrate good management practices as applied to farm woodland conditions. These tracts, under management for periods varying from 4 to 9 years, all show that the average woodland owner can obtain a good return for his labor every year while at the same time building up his growing stock. In the Southern Piedmont only 2 to 4 hours' labor per acre per year are required to realize an average annual roadside value of from $2.75 to $9.75 per acre for the products harvested. However, if a woodland owner expects to get full value from his forest, it is essential that he learn to apply a few simple management techniques such as are outlined in McClay's popular leaflet, "Managing Southern Piedmont Farm Woodlands Pays Dividends."

FOREST GENETICS

Increasing competition by lumber and veneer plants for the dwindling supply of high-quality timber plus a continued expansion of the pulpwood industry brings into sharp focus the need for full productivity of forest land. As a result, reforestation of idle land proceeds at an increased tempo, forest tree nurseries are being deluged with orders for seedlings, and many new nurseries are being established. This unprece-

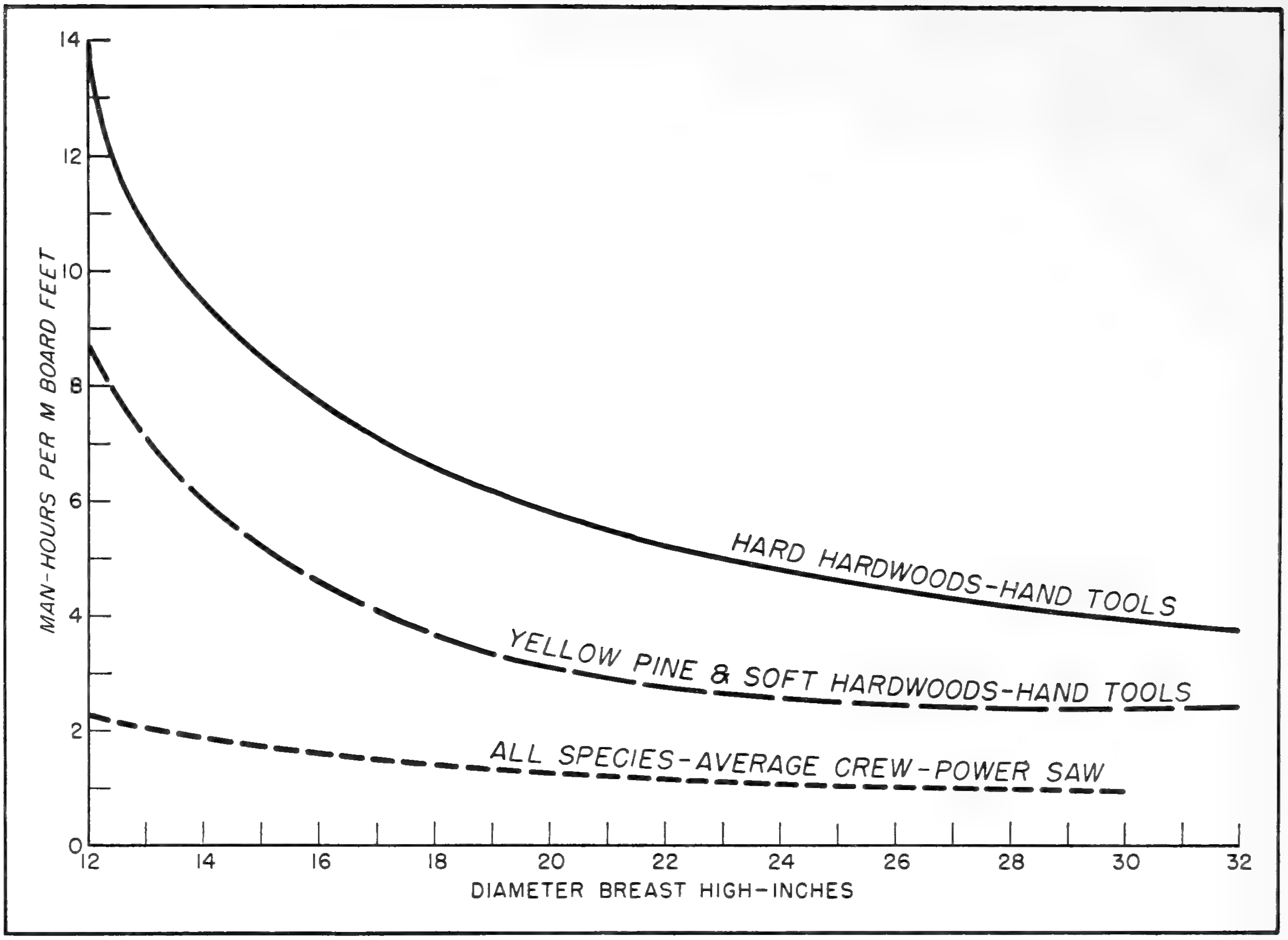

Figure 2.--Relation of felling and bucking time to tree size for different species groups in the Southern Appalachians.

dented demand can only be satisfied with correspondingly large quantities of seed which, quite naturally, are being obtained by local collectors where most abundant and cheapest. These collectors, having little interest in timber production, often pick cones without regard to the vigor, quality, or disease resistance of parent trees, but seek only those prolific specimens which are easiest to climb. This practice plus the creaming of natural stands for high quality products leads to degeneration of the crop. Thus landowners while stimulating reforestation efforts at present may be penalized in the future by the slow growth of inferior stands.

The genetic quality of the present forests can be maintained and those of the future improved by: (1) establishing new stands by planting or natural methods with seed from the best trees in the best stands; (2) making tests, with seed or grafted material of the best trees, stands, and races to isolate the best types, so that superior seed can be produced in the future; (3) starting a program of tree breeding to create new types.

This three-point program is the basis of Station activity in forest genetics. Detailed reports of "Geographic Differences in Cone-opening in Sand Pine," "Slash Pine (Pinus elliottii) its Nomenclature and Varieties," "Hereditary Variation as the Basis for Selecting Superior Forest Trees," "Suggested Projects in the Genetic Improvement of Southern Forest Trees," and "Directory of Forest Genetics Activities in the South," were published in 1952. The last three were prepared by or for the Committee on Southern Forest Tree Improvement, a South-wide group representing federal, State, industrial, and educational forestry interests.

The attempt to obtain better strains of slash, longleaf, loblolly, and shortleaf pine through individual tree selection in natural stands has been continued by K. W. Dorman in cooperation with the Ida Cason Callaway Foundation at Hamilton, Georgia. Progeny of some outstanding mother trees, even though the male parent is unknown, are as much as 50 percent taller at the end of one growing season in the nursery bed than those from other trees or from seed of commercial source. These seedling heights were compared on the basis of weight per thousand seed at time of planting. This has been true for the 1951 and the 1952 plantings.

At Lake City, Florida, evidence just obtained shows for the first time that oleoresin yield is an inherited character in longleaf pine. This study, begun in 1935, indicates the long-term nature of most forest genetics work and emphasizes the need for an early attack on fundamental problems.

Other studies at Lake City include hybridization tests with longleaf, slash, pond, and sand pine; development of improved propagation techniques; selection and outplanting of unusual specimens found among nursery-grown seedlings; establishment of two plots for demonstration of eugenic thinning operations, and conversion of existing stands into seed orchards.

Several of the Station's research centers are among the many participants in a major cooperative seed-source study of longleaf, slash, loblolly, and shortleaf pines. The study is spearheaded by the Southern Forest Experiment Station, under the sponsorship of the Committee on Southern Forest Tree Improvement.

NAVAL STORES

Bark chipping and acid treatment, a development of the Lake City Research Center, is rapidly becoming the accepted method of turpentining. In 1952 sulfuric acid was applied to nearly 20 million faces or about one-third of all those being worked. The new technique, when applied on a 14-day schedule, results in a 40- to 50-percent saving in the labor of chipping. This is a welcome saving to an industry currently plagued with labor shortages and mounting costs of production.

Techniques of Turpentining

Ten years' work with more than 70 pilot-plant operators indicates that thorough supervision of wood laborers is the secret of efficient,

economical gum production. Good supervisors insist upon (1) tight tin installations with minimum damage to the tree; (2) regular chipping schedules; (3) sharp bark hacks and good spray guns; (4) clean bark streaks of full face width; (5) uniform acid treatment from shoulder to shoulder at the point where wood and bark meet; and (6) prompt utilization of worked-out trees so that a new crop may be started.

Research in the development of better turpentining techniques is continuing with tests of gutter installations, variations in chipping interval and height of streak, and the effect of various physical factors on the yield of gum.

Gum Flow

An easily determined index of the gum-yielding ability of individual trees is essential for small-scale tests of turpentining techniques as well as for progeny testing in species improvement studies. Observations of gum-flow-rate patterns reveal that the yield from a single acid-treated bark streak applied in mid-summer is an excellent measure of the total yield from the same tree during an entire current season. This finding may greatly reduce the amount of woods labor involved in turpentine research and increase the precision of individual experiments.

Naval Stores Equipment

New or improved tools are needed for efficient application of the newly developed turpentining techniques. In earlier years engineers in the Equipment Project developed acid spray guns, spiral gutters, larger cups, spray-hacks, and spray pullers. To these have been added a rossing tool for removal of rough bark from trees about to be turpentined, and a nail-pulling device so that worked-out faces may be left free of metal. In addition the equipment engineers supervised a graduate student in the School of Engineering, University of Florida, in development and construction of a tool for sowing sand pine seeds.

COMPARTMENT MANAGEMENT

Long-term studies involving length of rotation, cutting cycle, silvicultural system, intensity of stand improvement, and the integration of turpentining, timber production, prescribed burning and grazing are being conducted on 5 experimental forests. These studies embrace 166 compartments of 30 to 100 acres in size. Formative cuts have been completed and preliminary results published for a majority of the areas. These compartments are of immediate value as a testing ground for results from small-scale, plot-type studies. On a broader scale, they provide opportunities for study of forest-land management practices and their interrelationships during successive cutting periods.

PILOT-PLANT MANAGEMENT

A 2200-acre tract on the George Walton Experimental Forest near Cordele, Georgia, is being devoted to a pilot-plant test of sustained-yield

management. The objective is to test the highest type of management that can be applied and to determine its profitability. Although only under fire protection and intensive management for 5 years, the project is beginning to produce interesting results.

Repeat measurements on a portion of the tract indicate that understocked young longleaf and slash pine stands are increasing in growth at a calculated rate of 27 percent in board-foot volume annually. Although saw-timber stands of merchantable size only occupy 56 percent of the total area, volume is increasing at the rate of 235 board feet annually.

This pilot-plant area was selected initially as representative of the middle Coastal Plain of Georgia. It is showing how the understocked stands common to the region can be built up rapidly by judicious timber cutting.

FOREST ECONOMICS

Timber Inventory of Georgia 79 Percent Complete

During 1952 the timber inventory of Georgia was completed in fifty-nine counties located chiefly in the southern Piedmont. The total area of forest land surveyed last year amounted to eight million acres. By the end of the year, the field crews had measured the timber on 6,766 sample plots, including those taken in 1950 and 1951, or 79 percent of the total scheduled for the State. Interest in the survey, on the part of forest industry and State agencies, continued at a high level as the Union Bag and Paper Corp., the Macon Kraft Co., the West Virginia Pulp and Paper Co., the Georgia Forestry Commission, and the Georgia School of Forestry all contributed to the progress of the field work.

Survey Reveals Improved Pine Timber Supply in Southeast Georgia

The southeastern Coastal Plain section of Georgia provides nearly one-half of the pine pulpwood cut in the State and a large part of the saw timber. In view of this heavy drain, up-to-date statistics showing the trend in timber supply are essential. Completion of the field inventory in southeast Georgia (Survey Unit 1) highlights the changes which have taken place between the original survey of 1934 and 1952. The total forest area has increased about three percent, but the acreage of pine types has decreased by nearly 750,000 acres. In spite of this reduction in pine acreage, improved fire protection and forest management practices have resulted in a 68-percent increase in stocking of sound pine trees 1.0 inches d.b.h. and larger. Saw-timber-size trees were 37 percent more abundant. As a result of this increase, the volume of pine saw timber was found to be 21 percent greater than in 1934. The volume of all pine timber 5.0 inches d.b.h. and larger increased 25 percent. These facts show that the forestry programs in this area are achieving results and also indicate

that the planned expansion of forest industrial capacity in this area is on a sound basis from the standpoint of raw material supply.

Techniques Improved for Predicting Growth

Estimates of timber growth prepared by the Forest Survey have for many years been based on the expected change during a specified period due to (1) increase in current growing stock volume; (2) ingrowth, or volume in trees which grow into merchantable sizes; and (3) mortality, or the volume in trees expected to die. An accurate determination of the volume of ingrowth is one of the most difficult to make, yet it is a very important part of any realistic growth estimate.

A number of methods of growth prediction have been used in the past but these are open to criticism because of the theoretical assumptions used. A revised method of computing ingrowth based on the growth of sample trees has now been developed.

The sample tree data obtained from ground plots are used to determine the proportion of trees now of volume size which were seedlings or saplings at the beginning of the 10-year growth period, or which started growing during the period. These proportions are applied to the current stand table to compute the total number of trees which reached the 6-inch diameter class during the past 10 years. Rates of diameter growth for individual sample trees are then tabulated to find out which year during the period each tree reached volume size. These tabulations are summarized and the number of trees recruiting each year are analyzed to detect trends in ingrowth which develop from better stocking of young trees or changes in stand structure. If a positive or negative trend exists, a regression curve or a simple average for late years during the period can be used to predict the number of trees which will reach pole size during the following year. Similar procedures are used to predict the number of trees which will recruit to saw-timber size. Volume tables are then applied to estimate the volume of annual ingrowth. In south Georgia, where inventory work was recently completed, this procedure showed a rate of ingrowth double that obtainable under previous methods because it took into account the progressive increase in the number of young trees in the stands.

Rate of Timber Use and Replacement High

Under a new system of tallying stumps on inventory plots to obtain drain estimates, the annual volume of pine timber drain in south Georgia (Units 1 and 2) was found to be 1,152 million board feet, or 8.6 percent of the available growing stock. This rate is surprisingly high since it means that the typical saw-timber stand is partially cut every twelfth year. A tabulation of areas on which stumps of recently cut trees were found also reveals that some timber cutting takes place on approximately 7 percent of the forest land area each year.

The rate of pine timber replacement through growth is also high for this area. In recent years the number of trees in the pole and sap-

ling sizes has been building up. This condition has created a sharp increase in the volume of ingrowth as these smaller trees reach saw-timber size. The average growth rate of pine timber under all conditions was 9.7 percent. In rapidly growing pole-timber stands the rate was as high as 13 percent.

Progress Made In Resurvey of North Carolina

With the cooperation of the North Carolina Department of Conservation and Development and its Division of Forestry, the field inventory of timber in southeast North Carolina (Survey Unit 1) was completed. Thus, as soon as office computations are finished, new timber statistics for nearly one-third of the forested area in the State will be available. This information is badly needed in this area, where the demand for timber has increased with the opening of one large new pulp mill and the development of a number of large barge and rail yards for the concentration of pulpwood. Reliable estimates of timber volume, growth, and drain will help to guide pulpwood procurement into timbered areas capable of supporting a heavier cut, thus minimizing overcutting around these concentration points.

Report on 1951 Production of Pulpwood Aids Industry

In 1951, pulpwood production in the Southeast (Station territory) amounted to 7.7 million cords, 13 percent more than in 1950. Hardwood pulpwood production, exclusive of chestnut, was 21 percent greater than in 1950. Georgia was the leading producer, accounting for 31 percent of all pulpwood cut in the Southeast. Reports on the production from each county were obtained and published. This county information continued to be useful to pulp companies as it made possible various analyses for specific wood procurement territories, usually composed of irregular groups of counties. Such analyses included the competitive relationship of pulpwood production, the intensity of production in relation to the total amount of growing stock, and the location of new areas from which to obtain pulpwood.

Sawmill Waste a Potential Source of Pulpwood

Southeastern sawmills are now turning out about 7 billion board feet of lumber annually. In the process, they also produce as waste some 7 million cords of saw-timber topwood, slabs, and edging strips suitable for chipping and conversion to paper pulp, building board, or other products. Yet the only present use for most of this material is as low-grade firewood. Recently, however, there has been great interest in waste salvage, particularly on the part of the pulp and paper industry and, with stumpage at its present high level, salvage operations may prove economically feasible. A waste marketing study being conducted by the Station in the South Carolina Piedmont highlights some of the potentialities and problems involved.

The study area is a circle of 30-mile radius, taking in portions of 11 typical Piedmont counties. It contains 147 active sawmills whose

production rates range from a few thousand to 3 million board feet per year. In 1951, they produced a total of 81.4 million board feet, 82 percent of which was pine. They also produced 50 thousand cords of mill waste and 36 thousand cords of logging waste suitable for chipping. This is equal to 40 percent of the present pulpwood production in the area.

The mill waste for an individual timber tract is usually concentrated at one mill set, occasionally at two or even three. Therefore, it would presumably not be difficult to load and transport. The logging waste, on the other hand, is widely scattered through the woods. Whether or not it is operable for a product such as pulpwood largely depends on its concentration or volume per acre. Waste volume per acre on 105 tracts examined ranged from 0.3 to 3.2 cords. However, only 14 percent of the total waste was in concentrations of less than one cord per acre; 58 percent was in concentrations of one to two cords; 28 percent in concentrations of more than two cords. Individual tracts ranged from 1 to 500 acres in size and averaged 77. There still remains to be determined the minimum operable volumes of logging waste, both per acre and per tract, and the most efficient methods of preparing, assembling, and transporting all classes of waste to market.

WATERSHED MANAGEMENT

Protecting Watershed Values by Good Forest Road Construction

Careless methods of forest road construction jeopardize water quality by adding to the turbidity and sediment in the streams. This occurs not only during use of logging roads but on one logged watershed at Coweeta the adverse conditions continued for 4 years following logging.

Good surface drainage of roads is a key factor in maintaining water quality as well as in minimizing road maintenance and equipment repairs. Problems in road drainage design and techniques for handling surface storm water were studied on temporary work roads and skid trails in mountain logging operations at Coweeta. It was found that self-cleaning properties for open top surface drains can be maintained when the length of the storm drain extending diagonally across the road is approximately twice the berm-to-bank road width. This means that the volume of storm water should not be so great that forest litter is unable to filter out the sediment before it reaches the stream channel. Information was obtained in 1952 on discharge of sediment from open top storm drains on forest roads having various grades and drainage spacings (fig. 3). These studies showed that when 20 cu.ft. or less of sediment per year is discharged from one of these drains, the forest litter filters it out, the storm water quickly soaks into the soil, and no pronounced rilling or wheel-rut wash occurs. Where 140 cu.ft. or more of sediment is discharged annually at one point, active gullying

occurs on the road surface and in wheel ruts, creating hazardous road conditions, increasing maintenance costs and decreasing traffic loads. The effect of these and intermediate practices upon watershed values is indicated in figure 3.

Effect of Land Use and Forest Management Practices on Trout Streams

Field work on a cooperative project with the North Carolina Wildlife Resources Commission and the U. S. Fish and Wildlife Service was begun in 1952. Sampling of fauna and flora along stream bottoms is under way. This information together with hydrologic data collected at Coweeta will be used to evaluate the effect of various land use and forest management practices on trout stream environment.

Stream temperature studies at Coweeta are giving a new concept for managing streambank vegetation. Following cutting of the laurel and rhododendron understory on a 70-acre watershed at Coweeta, water temperatures were maintained within limits of tolerance for trout. This cutting actually increased the period of optimum temperature necessary for growth and development of trout and the aquatic organisms upon which they feed. Clearing of riparian vegetation for limited stretches along a stream showed that it is possible to keep temperatures within optimum limits and in the open area produce more aquatic organisms plus better opportunities for fly fishing.

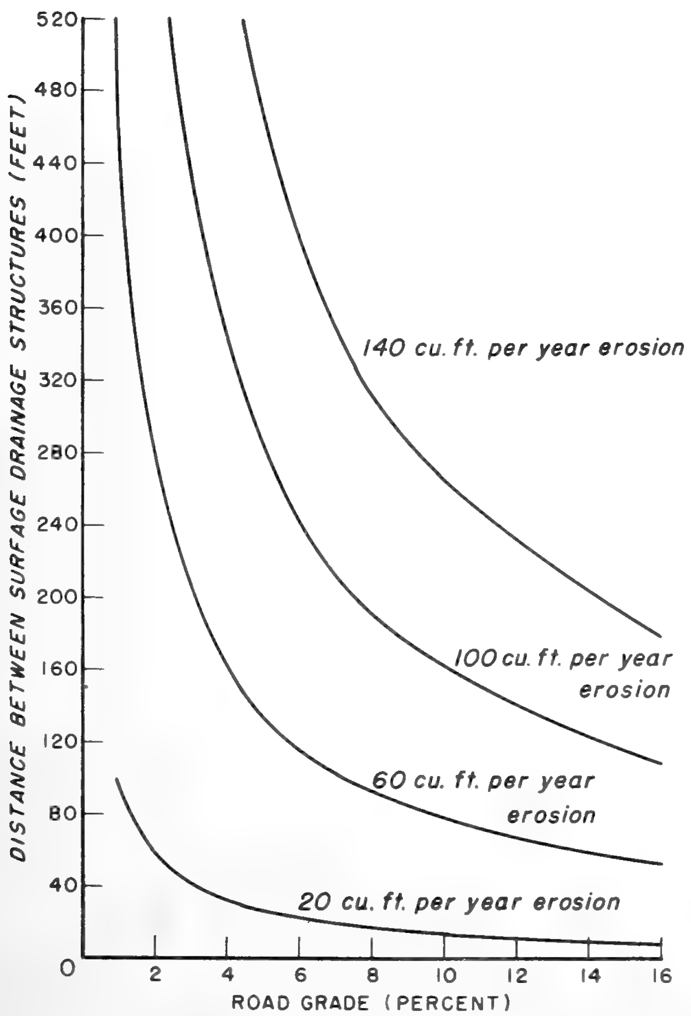

Figure 3.--Soil losses depend on road grade and distance between surface drainage structures.

Clearing of riparian vegetation along extended stretches of streams too small to sustain a fish population greatly increases stream temperature. With high temperatures, aquatic organisms far out of proportion to the stream's size are produced and flushed into the main channel, thus providing more trout food there. Consequently, a slight rise in water temperature of forested streams may be advantageous.

Basic Hydrologic Research

Records from 31 stream gages, 8 turbidity stations, 6 water temperature stations, 26 observation wells, 9 weather stations, 18 recording rain gages and 88 standard rain gage stations were taken currently at Coweeta during 1952. In cooperation with several universities, basic hydrologic data accumulated in the past from Coweeta were analyzed in the preparation of several graduate theses by students working part time at Coweeta. Based on these data in 1952, one Ph.D. was awarded, and two Ph.D. and three Master's theses were in progress.

Practical Value of Watershed Research

Furnishing information on water resource management and forest influences occupied a major portion of the Coweeta staff's time during 1952. Two training sessions each requiring 2 or more days, 11 illustrated discussions, and 65 tours were conducted for 754 visitors. In addition, over 60 inquiries on the technical phases of the research program were handled on a consulting basis or by correspondence. To help facilitate the dissemination of research findings at Coweeta, a movie, "Waters of Coweeta," was prepared. This film will inform people who cannot come to the area about Forest Service watershed management research in the Southern Appalachians and provide facts regarding land use practices.

Plans for 1953

Publications will be emphasized in 1953. Plans are to complete a report summarizing 17 years' research at Coweeta. Several papers will be written on basic research projects covering hydrology, forest management practices, and soils as they relate to stream flow. A long-range program conference is scheduled for April 1953. This conference will review research needs for continuing existing watershed treatments and suggest priorities for proposed watershed studies on land use, evaporation-transpiration studies, and integrating the silvicultural aspects of forest management and water resource management. The basic research projects on soils, climate and hydrology as they relate to stream flow will be continued.

FOREST SOIL-WATER RELATIONS IN THE PIEDMONT[1/]

The objectives of watershed management research at the Station's Piedmont Research Center are: (1) to learn what conditions are on forested watershed lands; (2) to work out methods for improving conditions where they are now unfavorable; (3) to develop practices which maintain present favorable conditions; and (4) to plan research so that results will promote a better fundamental understanding of watershed management.

Areas which have lost the original topsoil and are now barren or gullied constitute the most serious regional problem so far as erosion and floods are concerned. It is estimated that in the aggregate such areas constitute about 5 percent of the forested area. The majority of eroded material that muddies streams comes from these areas plus poorly farmed lands and old roads. Any rainfall in excess of an intensity of 0.10 inch per hour runs off from these areas. An ordinary thunderstorm of less than 1 inch of rain causes a muddy torrent to pour off these scalds and galls.

Where the original topsoil has not all been lost and a sandy surface remains, conditions are less serious and natural vegetation controls erosion. A good cover of broomsedge protects the soil surface but does little to loosen up the underlying heavy clay. Effective moisture storage during heavy rains occurs only in the topsoil layer. Where 4 to 6 inches of topsoil remain, an area in broomsedge has the capacity to store from 1.5 to 2.0 inches of rainfall before surface runoff begins. Although this is much better than a bare eroded area, surface runoff would still occur from about 25 storms per year.

The establishment of trees with their deeper-ranging root systems causes an increase in the permeability of the underlying clay and increases the capacity of the soil to store water. A 20- to 40-year-old pine forest on an old field site generally can store from 2.5 to 4.0 inches of rainfall in a 24-hour period. This capacity would be exceeded less than 7 times in an average year. With the passage of time the ability of the young forest to store rainfall increases, and eventually may reach that now found on the remnants of old growth forest. Measurements in the patches of old growth remaining indicate a storage capacity of more than 9 inches for a 24-hour period, and only rarely do storms exceed that capacity.

As a check on these determinations and to furnish further information, stream flow is measured on 4 small watersheds, and soil moisture observations have been taken under typical plant cover types to a depth of 6 feet in the soil. The soil moisture records show that tree roots draw moisture to depths below 6 feet and, in fact, it appears to be normal for trees to use all available water in the upper 6 feet of soil before the end of the growing season. Broomsedge with associated herbaceous vegetation has a more limited root system and normally dries the soil to wilt-

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1/ Joint project of Divisions of Watershed Management and Timber Management.

ing percentage only in the surface 3 feet of soil. On bare soil, evaporation dries the surface rapidly but the rate diminishes with depth, and even in the driest weather there is available moisture below 24 inches.

During the winter of 1950-51, rainfall was not sufficient to add moisture to depths below 3 feet in forested areas and because of this trees had little soil moisture available. In fact, after May 15, 1951, trees were almost completely dependent on current rainfall to meet their moisture needs. This helps explain the insect build-up and poor growth experienced during 1951. The early summer of 1952 was extremely hot and dry but forest growth suffered little, if any, because rainfall of the preceding winter was sufficient to raise the soil to field capacity during March. As a result, the surface 6 feet of soil had 7 inches more available moisture on April 1, 1952, than was present in 1951.

The job of restoring water storage capacity and fertility to the eroded soils of the Piedmont begins with improvement of the surface layers. This improvement will be brought about primarily by the vegetation on the site through the organic matter it adds to the forest floor. In order to find out how much organic material is added to the forest floor under various stand conditions, litter fall studies have been in operation for two years. Average values for the two years for stands growing in Union County, S. C., are given in the following table:

Table 2.--Organic matter added annually to forest floor beneath various Piedmont stands (oven-dry basis)

Stand composition	Leaf fall	Litter fall 1/
	Pounds per acre	Pounds per acre
75% loblolly, 25% shortleaf pine, age 26	3,685	4,733
Shortleaf pine, age 35	2,836	3,725
Loblolly pine plantation, age 11	3,461	3,885
Shortleaf pine-hardwoods, age 1-40	3,179	4,115
Hardwoods, age 1-50	3,600	4,372
Hardwoods, age 1-150	4,022	4,862

1/ Includes leaves, twigs, bark, and fruit.

Table 2 shows in general that leaf and litter fall are independent of species and age. From the above values a good working figure for leaf fall for Piedmont stands is 3500 pounds per acre, and for litter fall 4300 pounds. Although the quantity of organic material added varies little between the stands, the amount of nitrogen and calcium is much different. The leaf fall from pine stands contained 13 pounds of nitrogen and 18

pounds of calcium, whereas that from the hardwood stands contained 27 pounds of nitrogen and 88 pounds of calcium, per acre.

The quantity and quality of the material added to the forest floor determines to a large extent the amount of organic matter that is incorporated into the mineral soil. This incorporated organic matter is important because of the desirable physical and chemical characteristics it imparts to the soil. Table 3 gives the organic matter content of soils beneath Piedmont, Coastal Plain and Mountain forest stands.

Table 3.--Percent organic matter based on oven-dry weight of soil

Sample depth (Inches)	Union County, S. C.			Santee, S. C.	Coweeta, N. C.
	Aver. of three pine stands	Hardwoods 50 yrs. old	Hardwoods 150 yrs. old	Loblolly 50 yrs. old	Hardwoods old growth
0-1	1.37	6.07	10.24	11.21	12.83
1-2	1.01	3.68	5.85	5.63	7.87
2-4	.93	2.60	3.59	3.13	5.21
4-6	.84	2.07	2.21	1.70	3.82
6-8	.76	1.82	1.52	1.30	3.70
8-10	.69	1.84	1.25	1.12	2.25
10-12	.59	1.82	.91	1.10	1.71

Table 3 indicates that old field pine soils have a very meagre supply of organic matter. However, the potentialities of the soil are evident when one compares the 150-year-old Piedmont hardwood stand with the Santee and Coweeta stands. The Santee samples were collected near Charleston, South Carolina, and the Coweeta samples from the mountains of North Carolina on soil which has never been cleared.

Table 4 shows the nitrogen that is found in these same profiles. This table shows the general low nitrogen level of old field pine sites of the Piedmont. The importance of nitrogen to tree growth in the Piedmont region has been brought out by studies of the littleleaf disease by the Division of Forest Pathology.

Future studies will be concerned with evaluating the factors which determine the organic matter content of the soil and the physical properties which increase water storage capacity.

Table 4.--Percent nitrogen based on oven-dry weight of soil

Sample depth (Inches)	Union County, S. C.			Santee, S. C.	Coweeta, N. C.
	Aver. of three pine stands	Hardwoods 50 yrs. old	Hardwoods 150 yrs. old	Loblolly 50 yrs. old	Hardwoods old growth
0-1	.043	.175	.287	.320	.365
1-2	.033	.108	.169	.163	.226
2-4	.031	.078	.106	.093	.151
4-6	.029	.063	.067	.053	.112
6-8	.026	.056	.048	.041	.109
8-10	.024	.057	.040	.036	.068
10-12	.022	.056	.031	.035	.053

FIRE RESEARCH

Cumulative Danger Index

The Southern Appalachian region experienced one of the worst fall fire seasons in its history during the period mid-October to mid-November 1952. A prolonged drought plus occasional days of high wind taxed control agencies to the utmost.

One method of gaging the severity of the period is illustrated in figure 4. On it is shown a comparison of build-up for three different areas. The West Virginia and Kentucky curves show build-up during the critical burning period in the autumn of 1952. Similar conditions prevailed in many of the eastern states. The Maine curve represents build-up during the 1947 period of disastrous fires.

Steps involved in the derivation of a cumulative danger index cannot be briefly explained. Essentially, however, they consist of adding or subtracting daily departures from the "normal," established for each geographic unit by median data collected over a period of 8 years. Daily records are obtained through the use of a 100-point danger meter which integrates a number of variables measured at fire danger stations. Therefore, the cumulative danger index indicates the build-up of forest flammability above normal. An adjustment is made for rain: one inch or more of rain reduces the cumulative danger index to zero, and lesser rains in proportion.

Thus, during periods of normal fire weather the cumulative danger index remains at or near zero. During period of drought, when above-

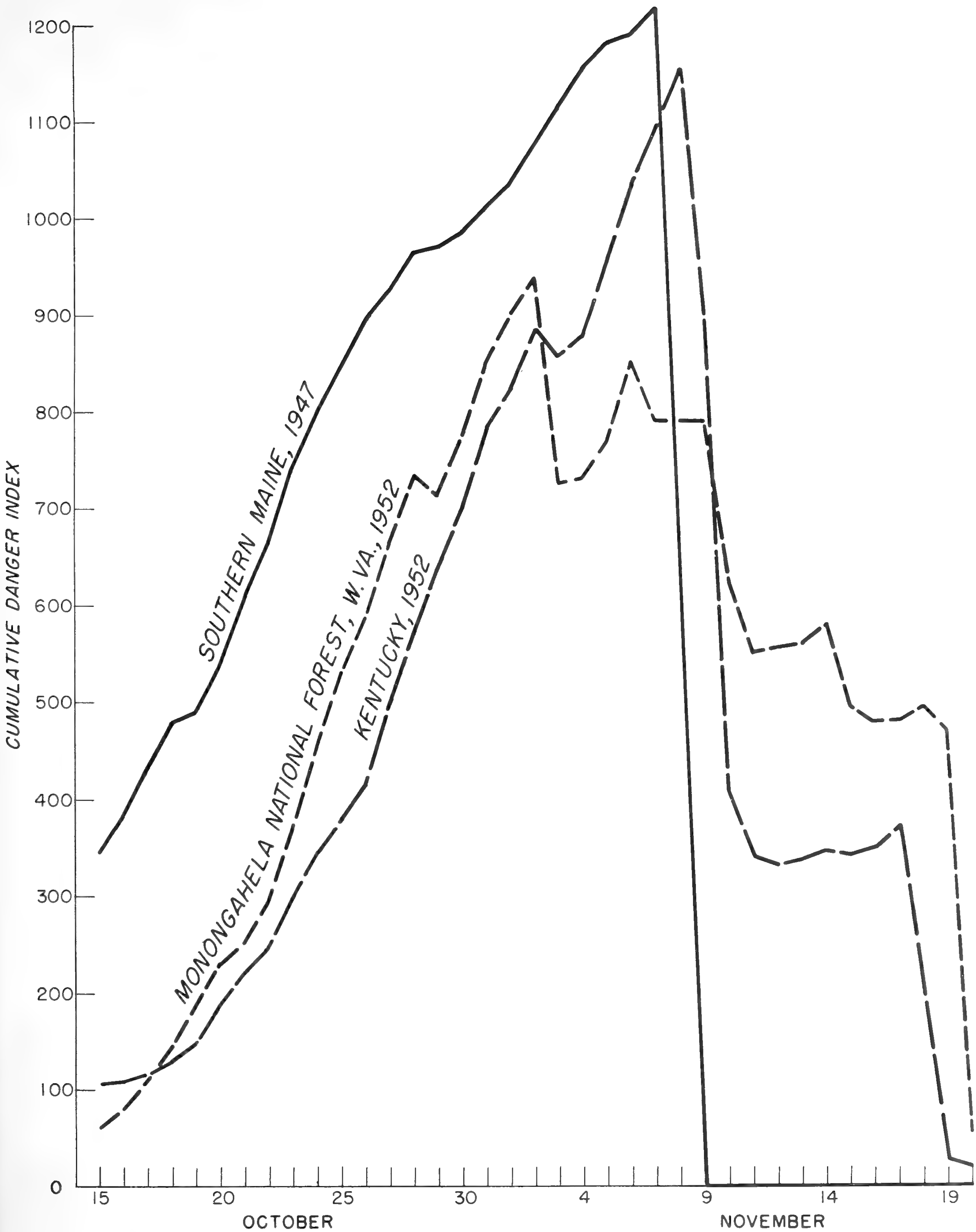


Figure 4.--Cumulative danger index curves.

normal burning index is measured, the cumulative danger index increases, sometimes to several hundred units, depending on the daily burning index and the duration of the drought. Any appreciable relief thereafter can only come from rain.

As shown by the graph, build-up of danger in the three areas was similar. This does not mean that the job load was the same for each, because many variables such as fuel type, flexibility and strength of organization, and soundness of attack are involved. The curves show, however, steadily worsening conditions as the season advanced.

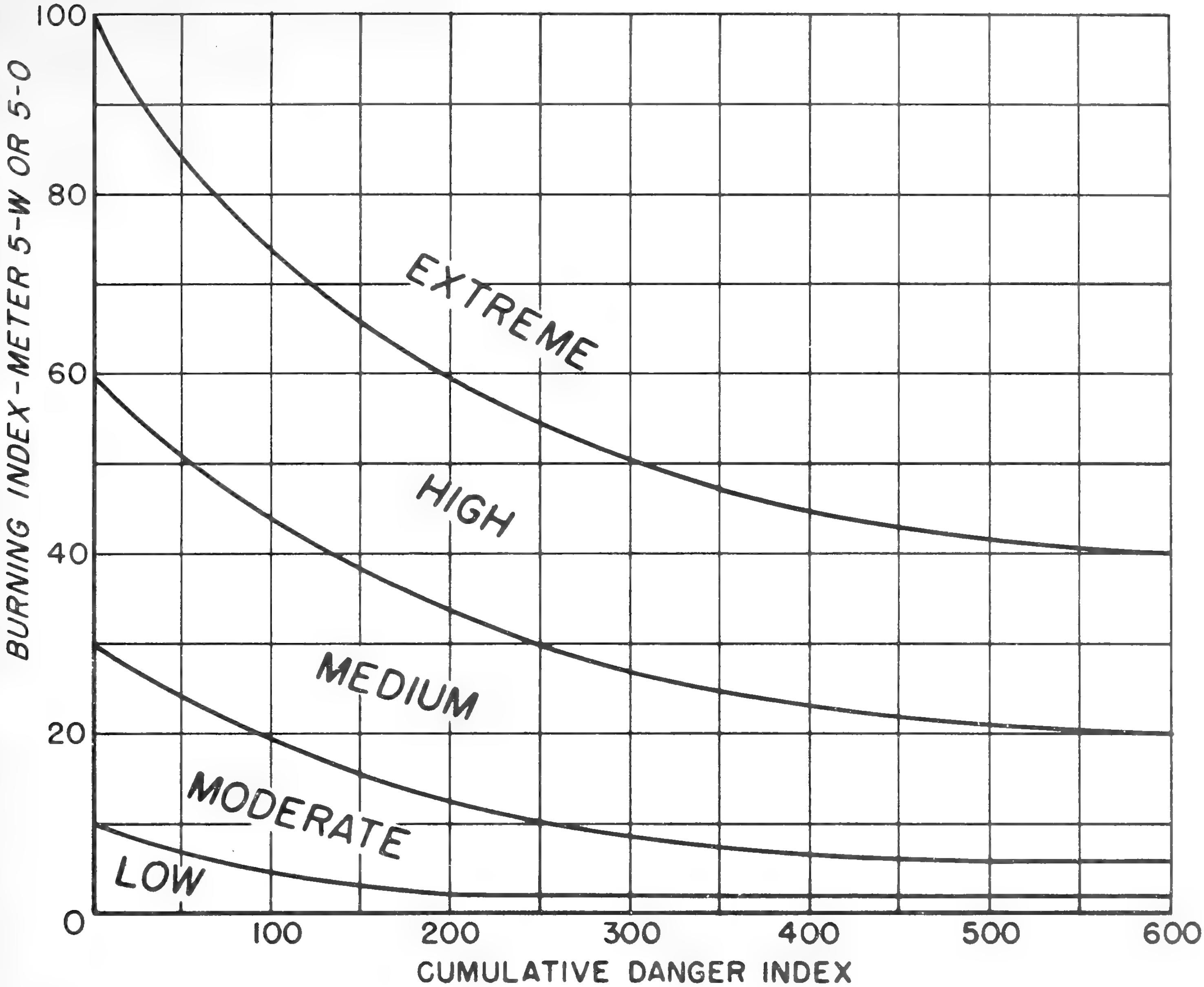
The cumulative danger index serves a useful purpose by alerting fire control organizations when above normal conditions exist. It is now in general use in the Northeast and in parts of the Southeast. On the basis of past records, woods have been closed in the "compact" States of New England and New York when the cumulative danger index averaged 200, and some areas have been partially closed at 100. Last fall, for example, Rhode Island woods were closed on the day the cumulative danger index reached 193.

Its use also forewarns of dangerous conditions during the "off fire season" months when fire control organizations are ordinarily not alerted. For example, in eastern Pennsylvania last summer on the Hazleton Unit the cumulative danger index exceeded 200 from June 12 through July 8. During this period a partial tower system was manned and extended mop-up and patrol was needed because of deep-burning fires. Increased resistance to control was also reported from this unit in October as the cumulative danger index mounted toward 300.

Similar reports from West Virginia, Kentucky, and other sections of the Northeast have suggested the need for a method of integrating the daily burning index and cumulative danger index so that preparedness would be stepped up during periods of drought. A tentative schedule for doing this is illustrated by the curves and recommended action shown in figure 5. The curves are theoretical and may be modified as experience dictates, and the action taken would, of course, vary to fit local conditions. Development of the cumulative danger index and its several uses are largely the work of collaborator J. J. Keetch, of Region 7.

Fire Danger Stations

Of the 374 fire danger meters requested by fire control agencies in eastern and southern states and furnished by the Station in 1952, 336, or 90 percent, were those with the 100-point scale. This is strong indication of preference for the 100-point scale over the earlier types that had only a few class gradations. Nine out of ten of the 100-point type meters were either type 5 or type 5-C, which give directly comparable indexes in the proportion of 1 to 2; the type 5 is standard for all the northeastern states and the type 5-C, for practical purposes, may now be considered standard for the southern group. The transition to the new type meters, which has been progressive since their introduction in the Northeast in 1947, is about complete. Hence, fire danger ratings based upon suitably located stations are now comparable from Maine to Texas.



<u>Recommended Action</u>

LOW--No fire control organization - issue burning permits.

MODERATE--Primary detection - skeleton organization - issue burning permits with caution below C.D.I. of 200.

MEDIUM--Full detection - complete full-time organization alerted.

HIGH--Fire control organization at peak strength. Patrols and standby crews on duty if needed because of poor visibility or other conditions.

EXTREME--Emergency condition - use emergency plans augmenting local facilities.

Note: During periods of high risk, such as hunting season, low visibility, etc., preparedness may be advanced one step.

Figure 5.--Integrating cumulative danger index with daily burning index (usually predicted 24 hours ahead). Some readers may wonder how a low state of preparedness can be justified when the cumulative danger index is up to five or six hundred. This would only occur on days of fog or light rain during a long drought; the situation is still potentially dangerous.

This greatly facilitates training programs, fire control planning, fire damage appraisals, and other fire activities which can best be done by sections or regions.

A considerable portion of the Division's effort during the year went into improving danger measurements and techniques, supplying and locating stations, training observers and inspecting their work, and analyzing records.

Atmospheric Stability and "Blow-up" Fires

In the light of present knowledge, four essentials for severe and erratic fire behavior are: plentiful fuels made inflammable by prolonged drought; dense conifer stands; a deep unstable or neutrally stable atmosphere, the lowest few hundred feet of which may be stable or unstable; and a critical wind speed and low wind shear (wind shear is the rate of change of wind speed with height). The first two factors were fairly well understood 2 years ago. During 1952 much more has been learned about the third factor. The possible importance of the fourth factor has become evident only within the last year. Investigations are continuing to determine the effect of low wind shear and critical wind speed on fire behavior characteristics, such as whirlwinds and updrafts.

Methods were worked out in 1952 for computing the temperature profile of an unstable atmosphere from radiosonde records.

There appear to be at least two meteorological conditions associated with the instability of the atmosphere on those days when unusual or severe fires have occurred. The atmosphere may be unstable in a region over which a cold front is passing, in which case the winds will be from the north or northwest. The atmosphere may also be unstable in the northwest quadrant of a stagnated high pressure area; winds in that quadrant would be from the south or southwest.

The most important development during 1952 concerned the heat engine analogy. This thermodynamic analysis has not yet been completed, but has either answered or indicated the answer to some of the more difficult problems of the study, such as the source and magnitude of the unusual turbulent energy of severe fires and the reasons why some of the worst fires occur at night. Most of the turbulent energy comes from the conversion of a fire's heat or thermal energy into the kinetic or turbulent form. The energy conversion process occurs in the convection column above the fire, but it can take place on a large scale only when certain stability conditions exist in the atmosphere.

The heat engine concept gives us a better picture of the "blow-up" process as well as a better understanding of the more general problem of the relation of the behavior of any fire, large or small, to the properties of the surrounding atmosphere.

FOREST UTILIZATION SERVICE

The reduction of wood waste keynoted the activities of the Forest Utilization Service in 1952. Since it was a busy year for southeastern wood-using industries, demands on the forests were heavy, resulting in more interest than ever in utilizing waste material.

In the interest of reducing waste and improving the amount of usable lumber, four short courses in sawmilling were conducted during the year and numerous sawmills were advised on proper methods of logging, grading, sawing, and seasoning lumber and wood products.

By sorting logs for their best use, waste, costs, and manpower can be reduced. An extensive study was made of factors affecting the quality of southern hardwood veneer logs and blocks. This included photographs of the defects on the surface of the veneer logs and subsequent photographs of the defects as the veneer was peeled down 1 inch, 2 inches, 3 inches, and on to the center of the logs. This research is the first step in the development of veneer log grades which will be vastly helpful in producing better products at lower cost. Two schools were conducted to teach foresters and industry representatives the methods of grading hardwood and pine logs and trees. The hardwood log grades were simplified and reduced to a grading stick so that an inexperienced person can readily compute the grade of the log from the information given on the stick.

As a direct result of the pine log grading school, one company had its research forester carefully grade several hundred pine logs and follow them through the mill, tallying the grade and footage obtained from each log. The Station is cooperating in an analysis of the data obtained, since valuable grade-yield information can be derived while assisting the company in the evaluation of the grading system.

A straw in the wind was a forestry workshop held in western North Carolina in 1952 at which approximately 30 teachers from the grammar and high schools of North Carolina spent 6 weeks accumulating information that they could pass on to the next generation of citizens. Forest utilization men conducting courses at the workshop were impressed by the teachers' interest in wood utilization and their concern for greater use of the slabs, edgings, sawdust and tree laps that accumulate each year in the Southeast.

In more than a hundred visits to wood-using industries during 1952, every effort was made to call attention to wood waste and to point out methods where savings could be made, not only in wood but in manpower and money. Faulty seasoning is a very common cause of unnecessary loss, and in nearly every plant visited some advice could be given on improved methods in the air-drying yard or in the dry kiln. Much time was spent with dry kiln operators in meetings and at plants to give them the latest dry kiln schedules and the best methods for drying wood safely without degrade. Quality control systems were recommended so that these difficulties could be discovered and corrected at the plant rather than in the home of the purchaser of the wood product, where the only result would be to give wood a bad name.

For a number of years experiments have been made to develop an automatic furnace using low grade and waste wood to cure tobacco. The model developed in 1950 was built on two additional farms this year. One operator liked it so well that he is making plans to market the furnace next year. A report has been prepared on the progress of this work and will be published shortly. Although the wood-burning furnace proved satisfactory, the furnace fired by sawdust continues to give some difficulty at high temperatures and work must be continued for another year before it can be recommended.

Another source of waste is found in the trees bypassed in the forests by loggers because of market conditions, ignorance, or prejudice. The hickories, some of the red oaks, some of the white oaks, and others which are inherently good woods and a source of added raw materials for industry are discriminated against primarily because of lack of knowledge as to how to use them. In addition to the Forest Products Laboratory, the State forestry schools and industry have been enlisted in the research program to solve this problem. The Forest Utilization Service has emphasized assistance to an industry that is attempting to utilize hickory or one of the other species that most operators either leave in the woods or poison. The ground work has been laid for a task force approach on the utilization of hickory and during the next few years approximately 30 reports will be prepared by the Station and cooperators to summarize all information available on this species. In addition, research will be started to fill the gaps of knowledge.

Utah and alligator juniper logs from the Southwest were shipped into the territory to a firm that manufactures cedar chests from eastern red cedar. These western species were cut into veneer to see if they might be used as a substitute for the eastern red cedar. Although the color and odor were not satisfactory for use in cedar chests and similar items, it was found that the species veneered very well and might find uses in furniture or containers. The results of this study may lead to new industries in the Southwest.

The main tool of foresters in the past for controlling growth and quality of wood has been environment. Foresters are finding a new tool in genetics. The old argument of the part played by heredity as against that played by environment applies to trees as well as people, but most authorities agree that it will be necessary to consider both if best results are to be obtained. The pulp industry is vitally interested in this question of growth and quality and the part that genetics might play in the picture. During 1952 field reconnaissance indicated that great possibilities lie in this field. Plans are being made to determine fiber qualities that are most desirable for the pulp industry and to follow through in learning how to obtain these fiber qualities by manipulating environment and heredity.

The entire field of wood preservation in the Southeast has taken on new life. Small hot-and-cold bath treating plants are springing up in many parts of the South to provide treated fence posts in an expanding grazing program. Even the large pressure-treating plants are going after

this market and are now treating fence posts in quantity and marketing them at a reasonable price. Cheaper post treatments with shorter life expectancy than pressure-treated creosote posts, are being provided by the salt treating agencies. A brand new process developed by the Taylor-Colquitt Company in South Carolina provides a post treated with copper naphthenate or pentachlorophenol that removes the preservative carrier by vapor drying, leaving a treated material so clean it can be handled, painted, or finished naturally with the only evidence of its treatment being its resistance to decay and termites. Realizing the importance of wood preservation in the Southeast, the Forest Utilization Service designed and assisted in presenting the first wood preservation short course to be given in this region. Foresters from the State Forest Service and the Extension Service took the course; now they can serve as retailers to pass the information on to hundreds of persons interested in the subject. The reception to this short course was so encouraging that it will probably be repeated in several southeastern states next year.

During 1952 a start was made in a detailed analysis of the problems of the Southeastern States in wood utilization. Because of the immensity of this job one research center area in the territory will be studied at a time and, working in cooperation with the research center leader, a report will be prepared on the problems in wood utilization in that section. This report will serve as a guide to the research center leader as well as to the Forest Utilization Service. When all research center wood utilization problem analyses have been prepared, which may take 3 to 5 years, it will be possible to prepare a general wood utilization problem analysis for the entire Southeastern States.

GRAZING FOREST LANDS

Efficient utilization of the forage resource for additional income and fire protection in Coastal Plain pinelands is the objective of the Station's grazing research. All grazing studies are conducted cooperatively with other federal and State agencies.

Cane Range

Our previous research in cooperation with the North Carolina Agricultural Experiment Station has shown that grazing in the cane type can be profitable to the cattleman as well as beneficial to the forest. Recent studies have been concerned with problems of forage and cattle management.

Best grazing rates.--Utilization of 55-60 percent of the total cane herbage is the maximum degree of use commensurate with sustained yields of forage and beef under continuous summer grazing. This is one conclusion from cooperative studies being published as a North Carolina Agricultural Experiment Station Bulletin. On highly-productive treeless range, this degree of use was obtained at a stocking rate of 2.8 acres per cow and calf

for a 6-1/2 to 7-month grazing season. With daily gains of 0.6 pound per cow and 1.1 pounds per calf, total annual production averaged 111 pounds of gain per acre at this rate of stocking. Although heavier grazing temporarily yielded higher weight gains per acre (up to 148 pounds), gains per animal were lower and forage production declined. Moderate grazing also appeared desirable from the viewpoint of fire hazard. Although reduction in fire hazard was roughly proportional to the degree of grazing over a relatively short period, indications were that continued overgrazing in summer would soon kill the cane and allow it to be replaced by weeds that are more inflammable.

Cattle performance.--Winter management, range quality, and breed of cattle affect productivity of range herds. Wintered under adequate farm conditions, but depending entirely upon cane range for 8 to 9 months, grade Hereford cows in the study referred to above weaned 350- to 400-pound calves and consistently produced 85 to 90 percent calf crops over a 6-year period. When maintained yearlong on less productive range, calves of similar Hereford cows have averaged only 271 pounds at weaning time the past 2 years. However, calves of Brahman-Hereford and Africander-Hereford crossbred cows have averaged 387 and 336 pounds, respectively, under the same conditions. Apparently inadequate nutritional levels on winter range have limited calf crops to an average of 50-percent for the 2 years. Winter management of range herds is receiving additional attention in the present program.

Wiregrass Range

The value and limitations of native forage in longleaf-slash pine flatwood forests have been fairly well established in our past research with the Georgia Coastal Plain Experiment Station, and are summarized in pending State and federal publications.

Although burning improves grazing values, forage quality is not adequate to satisfy the requirements for lactation and for reproduction at the same time. Consequently, 50-percent calf crops and 275-pound calves are about all that can be expected from herds depending primarily on this kind of native range. A minimum level of fall and winter supplementation to prevent starvation death losses is approximately 1 pound of protein meal per head per day after October 15, and dry lot maintenance on hay or chopped sugarcane plus protein meal from February 1 until burned range is ready to graze in mid-March. Recent studies have explored possibilities for improving cattle production by supplementing native range in summer.

Supplementing forest range in summer.--Effects of supplementing summer range with protein meal have been studied 5 years, and the use of improved pasture as range supplement has been tested 2 years.

Supplemental protein feed increased calf weaning weights 65 pounds (360 vs. 295), and the percentage calf crop 9 percent (64 vs. 55). In addition, summer gains of nursing cows were increased 77 pounds, and dry cows 53 pounds. Approximately 250 pounds of supplement were fed per cow (2 pounds per day during the breeding season and 1 pound thereafter) plus 90 pounds per

calf. This supplemental feeding was practical only for nursing cows because dry cows usually bred successfully without summer supplement, and they lost most of the extra summer gain during the fall and winter.

Improved pasture is apparently better than protein feed for supplementing native range, according to preliminary results of tests exploring methods of integrating pasture and range for most efficient use of the cheap native forage. Compared with herds on unsupplemental range, transferring range cows to improved pasture (1-1/2 acre per cow) after July 1 increased average calf weights 156 pounds at weaning time. A limited amount of pasture (1/2 acre per cow) plus range during the same period was also effective - 129 pounds' increase. In comparison, calf weights these years were increased only 56 pounds by supplementing the range with protein meal (340 pounds per cow and calf over a 6-month period). In range herds receiving no summer supplement, weaning weights averaged 300 pounds for these two years. Evaluating the calves at 25 cents per pound, and deducting the cost of feed and pasture (establishment and maintenance only), shows increased returns per calf from the supplements as follows: limited pasture $25; full pasture $18; protein meal $6. A limited amount of supplemental improved pasture has been more effective when reserved until midsummer than when it has been continuously available, spring to fall. Continuous close grazing apparently reduced forage yields and, consequently, cattle gains. The improved pasture in these tests was a mixture of Louisiana white clover and Dallisgrass.

<u>Improving range forage</u>.--Past studies have shown that improved forage species can be introduced successfully into forest range. Legumes require no seedbed preparation other than burning the native sod and grazing the regrowth, but disking or chopping is desirable for introduced grasses. Although most improved species require fertilization, the requirements of some, such as lespedeza and carpetgrass, are lower than others such as big trefoil and Dallisgrass.

Relative returns from "high level" improvement with big trefoil and Dallisgrass, versus "low level" improvement with lespedeza and carpetgrass have been tested 2 years with yearling cattle. Weight gains per acre have averaged 151 pounds on big trefoil-Dallisgrass ranges, and 75 pounds on lespedeza-carpetgrass ranges. These gains are directly proportional to the rates of fertilization, 400 and 200 pounds per acre annually. Comparable gains on unimproved range were approximately 20 pounds per acre.

FOREST PATHOLOGY[2/]

Littleleaf Disease of Pine

Twelve years of research on littleleaf has been summarized in a technical bulletin manuscript to be published in 1953. The theory is developed, supported by much experimental evidence, that littleleaf results primarily from a nitrogen deficiency of the tree due to the killing of fine roots by the fungus *Phytophthora cinnamomi* under conditions of poor subsoil drainage. A field method has been developed for predicting the littleleaf potential of a site, based on simple soil criteria. Cutting practices to minimize littleleaf losses have also been formulated.

Programs on selection and breeding for littleleaf resistance in shortleaf pine and on the testing of 12 geographic lines in 3 states, for resistance, were started in 1952. The developments indicated above are aimed at making use of our considerable fund of knowledge on this disease in either predicting where losses will occur or in preventing and reducing losses.

Oak Wilt

Additional surveys bring the total counties where oak wilt has been found in the Southeast to the following: West Virginia, 22; Virginia, 1; Kentucky, 3; Tennessee, 6; and North Carolina, 3. This is an increase of 8 counties over 1951. The disease appears to be spreading slowly in the Southeast.

The causal fungus fruits abundantly under the bark of some diseased trees, and insects coming in contact with the spores are potential agents of spread. Twenty-three oak wilt trees were felled, and certain logs of each tree were barked, some left unbarked, some sprayed with insecticide-fungicide mixtures, and some unsprayed. Spraying logs with the bark on very greatly reduced insect activity under the bark and on the fungus mats themselves, for the first several months. Barking completely prevented the formation of fungus mats and bark and cambium insect activity.

Miscellaneous Pathology Developments

Mimosa wilt.--Mimosa seedlings dipped for 24 hours in solutions and then inoculated showed the following survival percentages from wilt at the end of the summer: Dithane (D-14) 92%, Vancide (51) 62%, Systox 22%, C-162 20%, Fermate 12%, C-1207 10%, Orthocide-406 10%, oxyquinoline benzoate 10%, water 5%. Dithane and Vancide look particularly promising for further work.

2/ Report of the Division of Forest Pathology, Bureau of Plant Industry, Soils, and Agricultural Engineering, in cooperation with the Southeastern Forest Experiment Station.

Needle cast.--The ability of Hypoderma lethale to cause spring needle blight has been demonstrated by inoculation.

Fomes annosus.--This fungus, which causes the most serious conifer plantation disease in Europe, and has caused root and butt rot elsewhere in the U. S., has been found causing extensive root rot and bark killing at the root collar in a 15-year-old slash pine plantation in South Carolina.

New Virginia pine rust.--This stem rust, described for the first time last year, has been found in additional areas in Virginia and Tennessee. At this time it is not regarded as a threat to this species although it kills trees, and its alternate host, if it has one, is not known.

White pine blister rust (B.E.P.Q. cooperating).--A 1-acre study plot in a rusted stand in Ashe County, North Carolina, at elevation of about 3500 feet, shows what the rust can do this far south.

Table 5.--Blister rust mortality on a study plot in North Carolina

Tree size in 1946	Total trees	Dead due to blister rust 1946	1948	1950	1952
	No.	Percent	Percent	Percent	Percent
Over 10 feet high	117	1	2	4	8
1-10 feet high	34	1	6	15	32
Under 1 foot high	100	0	2	2	8

Naval stores pathology.--Heavy pitch-soaking of the wood of certain slash and longleaf pines resulted, in a single year, from certain combinations of wounding and fusarium inoculation, and further trials were installed. All the work on prolonging gum flow and on pitch-soaking wood by fungus inoculation for the past 3 years has been brought together in a single report.

Blight resistant chestnuts.--A large number of demonstration plantings of high-quality Chinese chestnuts planted on good sites have been established throughout the Southeast, as far south as Florida.

Service to the Navy.--Much of the time of one man during 1952 has gone toward the inspection and treatment of wooden boats for decay and in dehumidification experiments at several yards and bases.

Disease inquiries.--A tally of inquiries shows 283 were handled in 1953, as compared with 233 in 1951, exclusive of special surveys.

BLISTER RUST CONTROL[3]

Blister Rust Control operations are on a maintenance basis in Georgia, North Carolina, South Carolina and Tennessee. Only periodic re-examinations of control areas to keep abreast of ecologic changes and other factors that may adversely affect the current status of *Ribes*[4] suppression in these states will be required. In Virginia and West Virginia, where *Ribes* are more generally found, suppression work must be continued on 313,000 acres, since the number of bushes occurring on this acreage has not been reduced to the maintenance standard.

Blister rust is being found in more and more isolated, unprotected areas in North Carolina and Tennessee. It is found generally in Virginia and West Virginia where *Ribes* grow in association with white pine.

The accelerated planting program in the Southern Appalachian States places increased responsibility on individuals and agencies where white pine is involved. These groups should make every effort to determine whether gooseberries or currants, both wild and cultivated, are growing within 900 feet of planting sites. Failure to take this precaution can result in complete loss of plantations of white pine if *Ribes* are present. Blister Rust Control personnel of the Bureau of Entomology and Plant Quarantine at Asheville, North Carolina, Pipestem, West Virginia, and Harrisonburg, Virginia, will gladly furnish information regarding *Ribes* distribution in the control area and make recommendations regarding questionable sites prior to planting.

3/ Report of the Division of Blister Rust Control, Bureau of Entomology and Plant Quarantine, in cooperation with the Southeastern Forest Experiment Station.

4/ Wild and cultivated currants and gooseberries, which are alternate host for white pine blister rust fungus.

FOREST INSECT CONDITIONS IN THE SOUTHEAST DURING 1952[5/]

The desire for more information on forest insect losses in the Southeast and methods of reducing these losses has demanded increased attention during the past few years. Foresters and woods workers in this area have been alerted through training sessions, correspondence and personal contact to watch for insect outbreaks. Report forms, mailing tubes and instructions pertaining to the collection of insects have been provided for reporting serious or unusual insect activity. All reports received by entomologists at this laboratory have been investigated and control methods recommended, when such were indicated or available. The increased number of reports of insect activity indicates that increased cooperation and coverage is being obtained each succeeding year.

Southern Pine Beetle

The southern pine beetle, *Dendroctonus frontalis*, outbreak in loblolly pine which occurred during 1951 in southeastern North Carolina has abated.

During 1952, reports of infestation were received and investigated from every State in the Southeast. An owner near Cheraw, South Carolina, lost about 10,000 board feet in May 1952, where infested trees were cut and burned. Loss of about 30,000 board feet of shortleaf pine in Leslie County, Kentucky, continued in 1952 but the infestation appeared to be declining. The principal control in Kentucky is apparently being effected by the pileated woodpecker. Supplementary control measures consisted of locating infested trees from the air and detailing crews to locate, cut and burn them. During August 1952, an infestation near Franklin, Virginia was investigated in which approximately 25,000 board feet of loblolly pine was killed. Infestations had built up slowly adjacent to lightning-struck pines and had not spread rapidly. All wood down to a 3-inch diameter limit was utilized and the bark burned. During this same month an attack on 5-10 acres of loblolly pine near Wilma, Florida, was investigated. Those trees which still contained broods were sprayed with 0.5 percent gamma benzene hexachloride in fuel oil. An attack on several hundred trees occurred in the Great Smoky Mountains National Park in September. Infested trees were cut and treated with orthodichlorobenzene in fuel oil. An infestation of about one-third acre was observed near Marion, North Carolina, in October, and about 60 acres containing approximately 300,000 board feet in 40 beetle-killed areas of shortleaf and Virginia pine were detected during this same month on the Tallulah Ranger District in Georgia. Salvage cutting with destruction of the slabs was recommended.

Black Turpentine Beetle

The black turpentine beetle, *Dendroctonus terebrans*, as in the previous two years continued to attack and kill a considerable volume of

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5/ Report of the Division of Forest Insect Investigations, Bureau of Entomology and Plant Quarantine, in cooperation with the Southeastern Forest Experiment Station.

pine in northcentral and northeastern Florida. In northeastern Florida three general zones of infestation totaling 43,000 acres were located. Within these zones about 10,000 acres was estimated to have been attached rather severely, with some individual gum producers losing as high as 40 percent of the total number of stems in portions of their most heavily turpentined stands. In November it was determined that attacks decreased by 78 percent in the older centers of infestation during the latter half of the year. About 6,500,000 board feet was killed by Ips and the black turpentine beetle combined during 1952 in this area. Of this amount, about 5,000,000 board feet was salvaged.

In one area in northcentral Florida the attacks have continued unabated with little indication of any decrease in activity on about 9000 acres. The attacks are concentrated on about 4500 acres of slash pine in so-called pond areas. Trees in these areas were operated for naval stores until the present infestation started in 1950. Because of the aggressive nature of the infestation, the area is being clear cut, leaving seed trees. Three million board feet of the expected cut of about 13 million board feet is estimated to have been attacked during 1952 by the black turpentine beetle.

Ips Beetles

Infestations by Ips beetles continued to exact as heavy a toll of pine timber in 1952 as they did in 1951. The areas of severest attack occurred across northern Florida and southern Georgia, where it was common to observe mile after mile of dead and dying pines along the roads. Pines in the vicinity of pulp mills, as well as those affected by drought and fire, were especially susceptible to attack. In 1951 it was estimated that 126 million board feet of pine were killed on commercial forest lands by Ips in the Southern Region of the Forest Service. Of this amount about 60 million board feet was estimated to have been killed in the Southeastern States. An equal or greater amount is believed to have been killed during 1952. Due to the nature of attack, by this beetle, it is impossible to obtain accurate loss information figures. Attacks by this beetle are generally scattered over a few trees to the acre. The Southeast has approximately 62 million acres of commercial coniferous type subject to attack from Ips beetles.

The Pine Needle Aphid

An aphid-like insect, Pineus pinifoliae, of the family Chermidae, infested approximately 30,000 acres of eastern red spruce along the tops of the Southern Appalachians during May and June 1951. Adults of these insects flew to white pine, the alternate host, where they oviposited on the needles. When the eggs hatched, the crawlers attacked the new growth of white pine by piercing the twig with their mouth parts. Killing of the terminals of white pine in localized areas resulted. Observations were continued in 1952 to determine whether additional damage occurred in the spring when the crawlers resumed feeding. No additional damage was noted. Survival of the crawlers over the winter was estimated at less than one-tenth of one percent. Observations on damage to white pine were made in areas which were heavily attacked. Understory and

suppressed white pine were killed, while dominant, codominant and intermediate trees survived. In instances where trees were heavily attacked and survived, the lower branches were generally killed.

Nantucket Pine Moth

The Nantucket pine moth, Rhyacionia frustrana, continued to be a serious pest of loblolly pine plantations and reports indicated that damage was more severe in 1952 than in previous years. The entire lower Piedmont and upper Coastal Plain areas of Georgia, North Carolina and Virginia were seriously affected. One block of about 500 acres near Americus, Georgia, had practically every tip hit on trees from a few feet to 20 feet tall. In several cases R. rigidana has been found in association with R. frustrana. R. rigidana will attack tips of pine trees of practically any height.

Loopers

Defoliation of hardwoods, especially oak and hickory on about 14,000 acres in western North Carolina occurred in May 1952. Several species of loopers including Alsophila pometaria, Erannis tiliaria, and Phigalia titea (Geometridae) were found defoliating black locust, red gum, red maple, sourwood, and dogwood as well as oak and hickory. On heavily defoliated areas only the leaf midribs remained. Thirty-three areas of defoliation varying in size from 40 to 1900 acres were reported or observed. These were concentrated principally along the ridges south of the line separating Haywood from Jackson and Transylvania Counties. The defoliated trees put out a second set of leaves during the months of June and July.

Miscellaneous Forest Insects

A pine sawfly, Neodiprion americanus, was reported in February 1952 as causing severe defoliation to pond, longleaf, and slash pine near Folkston, Georgia. Investigation revealed that about 10 acres of pine had been defoliated. Heaviest defoliation occurred on pond pine which in many cases were completely stripped of needles. By early April the buds had burst and the trees were putting out new needle growth.

Early in June this same species was reported as causing severe defoliation to loblolly pine along the coast of Virginia. Loblolly pine 35-55 feet tall were being stripped of their old needles by this sawfly. The new foliage which had been put out by the trees during 1952 was not attacked. Areas of infestation in Virginia varying in size from 1 to 5 acres were reported from Ware Neck, west of Mobjack, east of Mathews, Gwynn Island, northeast of Heathsville, west of Lewisetta and near Cole Point.

The locust leaf miner, Chalepus dorsalis, in 1952 again caused severe browning and defoliation of the foliage of black locust throughout the Southern Appalachians. Browning of foliage was observed in eastern Tennessee and Kentucky during the early part of July. Browning of leaves in western North Carolina was not common until the early part of August. This defoliation is not considered serious.

The mimosa webworm, Homadaula albizziae, continued to cause severe defoliation of honey locust and mimosa in several localities in North Carolina. It was also reported as causing heavy defoliation in several localities in South Carolina.

The pin oak sawfly, Caliroa lineata, which was reported as being present in the State of North Carolina in 1951 for the first time, did not increase during 1952.

About 250 acres of turkey oak were completely defoliated in Bladen County, North Carolina in September by the variable oak leaf caterpillar, Heterocampa manteo. Heavy defoliation of blackjack oak in Aiken and Lexington Counties, South Carolina was also reported. This species often causes sporadic outbreaks in the hardwood forests.

The gregarious oak leaf miner, Cameraria cincinnatiella, became abundant in Gaston County, North Carolina in August on chestnut, red and post oaks.

Numerous reports were received of injuries caused by adult feeding of borers and weevils. In some cases reproduction had been killed by the Pales Weevil, Hylobius pales, while in other cases scarring or deformation injury had been caused by feeding of round-headed borers (Cerambycidae), and flat-headed borers (Buprestidae). Early feeding by adult borers on buds of slash pine before they opened in April on a 100 acre tract in Florida caused the elongating new growth to twist into a complete circle in some instances.

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